

THE EFFECTS OF DIFFERENT GRAZING INTENSITIES ON VEGETATION COMPOSITION IN THE PALO VERDE MARSH

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Abstract: Wetland systems are ecologically important, and their management requires detailed knowledge of their dynamics. Our study addressed the efficacy of different levels of cattle grazing as a management tool for maintaining plant diversity in the wetlands of Palo Verde National Park, Costa Rica. We hypothesized that percent cover of grass species would be lower and plant species richness higher in areas of heavier grazing. We found that the low grazing site was dominated by a grass species (*Hymenachne amplexicaulis*) and an aquatic herb *Thalia geniculata*, while the high grazing site included these two plant species, plus four species that were unique to that site. We propose that high intensity grazing may limit the abundance of competitively dominant plant species and allow a richer plant community to develop than in low grazing sites. Our findings are relevant to the development of management strategies to restore and maintain biodiversity of wetland ecosystems.

Key Words: cattle, *Typha dominguensis*, wetlands management

INTRODUCTION

The development of management strategies to maintain the vegetative diversity in wetland ecosystems requires knowledge of the competitive interactions among plant species. The wetlands along the Rio Tempisque in Palo Verde National Park, Costa Rica, are important habitat for a host of bird and other wildlife species. Historically, cattle grazed in the marsh, but were excluded in 1981 when Palo Verde National Park was established (Gill 1989). Since that time, the marsh has experienced a dramatic shift in plant species composition (McCoy and Rodriguez 1994). When cattails (*Typha dominguensis*), which are considered undesirable, began to dominate the plant community, the species richness of plants declined. In an attempt to restore plant species richness and habitat for resident and migratory birds, managers reintroduced cattle in 1987 (Kim et al. 1999). Although this reintroduction has mitigated the dominance of cattails, preliminary studies indicated that overall plant richness has not increased, apparently because cattails have tended to be

replaced by a single dominant grass species (Kim et al. 1999).

While the qualitative effects of grazing have been explored, little is known about the effects of different grazing intensities on the plant cover and richness of the marsh. Grazing might increase plant diversity if it exceeds some threshold level of intensity that is required to preclude the dominance of one or a few species (Main 1993). Thus, we hypothesized that different intensities of grazing in the Palo Verde marsh affect plant composition. We predicted that (1) the percent cover of grass species would be lower in a high grazing site than in a low grazing site, and (2) plant species richness would be greater in a high grazing site than in a low grazing site.

METHODS

This study was conducted on 13-14 January 2000 at two sites representing areas of low and high grazing intensity. The low grazing site (grazed by 200-head of cattle/km shoreline for the past 6 years) was adjacent to the OTS station at Palo Verde, and the high

grazing site (grazed by 800-head of cattle/km shoreline for the past 6 years) was about 1.5 km E of the station, near the park headquarters (Gonzalez, personal contact). At each site we haphazardly established a rectangular plot extending 25 m into the marsh and 40 m along the shore. Within these plots we sampled five randomly chosen replicate transects running the length of the plot, and parallel to shore. The first 5 m from shore were not sampled to ensure that transects would not overlap projections of dry land from shore. At 2 m intervals along each transect we identified and recorded the plant species touching each transect line. Plant species were identified using Hernandez (1993). Open water was treated like a species category.

Within each transect, percent cover by species was calculated by dividing the number of points where a species was recorded, by the total number of points sampled. Mean percent cover of each species was then compared between sites using a Student's t-test.

RESULTS

The percent cover of the grass species *Hymenachne amplexicaulis* and tall, upright aquatic herb *Thalia geniculata* were both significantly greater in the low grazing site compared to the high grazing site ($t = 3.38$, $df = 8$, $p = 0.01$ and $t = 5.35$, $df = 8$, $p = 0.001$, respectively; Fig. 1). *Echinodorus andrieuxii*, *Eleocharis elegans*, and *Nymphaea sp.* all had significantly higher percent cover in the high grazing site, and in fact, never appeared in our samples from the low grazing site ($t = 10.93$, $df = 8$, $p < 0.001$; $t = 17.95$, $df = 8$, $p < 0.001$; $t = 3.81$, $df = 8$, $p = 0.005$; respectively). Only *Anisera martinicensis* was not significantly different between grazing sites ($t = 1.00$, $df = 8$, $p = 0.35$). The percent cover of open water was marginally greater in the high grazing site than in the low grazing site ($t = 1.90$, $df = 8$, $p = 0.094$).

Species richness was greater in the high

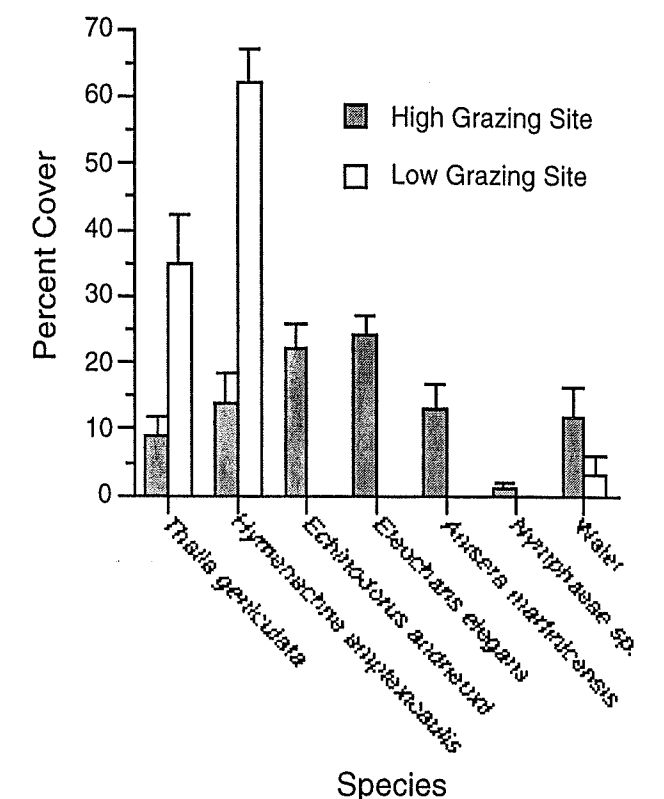


Figure 1. Percent cover (\pm SE) of plant species in high and low intensity grazing plots. $N = 5$ transects per grazing site.

grazing site than in the low grazing site (Table 1), with no single species representing more than 30% of total cover. In contrast, one species (*H. amplexicaulis*) in the low grazing site occupied 60% of the total cover.

DISCUSSION

Our results show that percent cover of grass species was lower and species richness higher in the high grazing site than the low grazing site. The grass species *H. amplexicaulis* dominated in the low grazing site, but not the high grazing site. This grass is likely to be competitively excluding other species in the low grazing site (Table 1). In the high grazing site, eating or trampling may decrease grass densities and allow less competitively dominant species to establish, resulting in greater species richness. Thus, our data support the proposition that disturbance can increase or

Table 1. Plant species within areas of the Palo Verde marsh exposed to either high or low grazing intensities.

Family	Growth Form	High grazing intensity	Low grazing intensity
Marantaceae	Upright aquatic herb	<i>Thalia geniculata</i>	<i>Thalia geniculata</i>
Poaceae	Grass	<i>Hymenachne amplexicaulis</i>	<i>Hymenachne amplexicaulis</i>
Cyperaceae	Reed	<i>Echinodorus andrieuxii</i>	-
Alismataceae	Upright aquatic herb	<i>Eleocharis elegans</i>	-
Nymphaeaceae	Water lily	<i>Nymphaea</i> sp.	-
Convolvulaceae	Vine	<i>Anisera martinicensis</i>	-

maintain diversity (Connell 1978).

Structural diversity in the Palo Verde marsh increased along with richness in the high intensity grazing site. This site had a greater percentage of both low-lying vegetation such as water lilies (*Nymphaea* sp.) and open water, which represent preferred foraging habitat for *Jacana spinosa* and other aquatic bird species in the marsh (Mahar et al. this volume).

As a National Park, Palo Verde is ecologically, culturally, and economically important. Management strategies are the subject of continuing debate. If the primary management goal is to increase plant species richness of the marsh, then relatively higher grazing intensity is preferable. However, additional research will be needed to assess other effects of grazing in the marsh ecosystem, including potential impacts on nutrient cycling, the terrestrial habitats around the marsh, and other invertebrates and vertebrates that depend on marsh habitats.

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